UM0239
User manual

ST7540 Power Line Modem Demokit
Graphical User Interface (GUI)

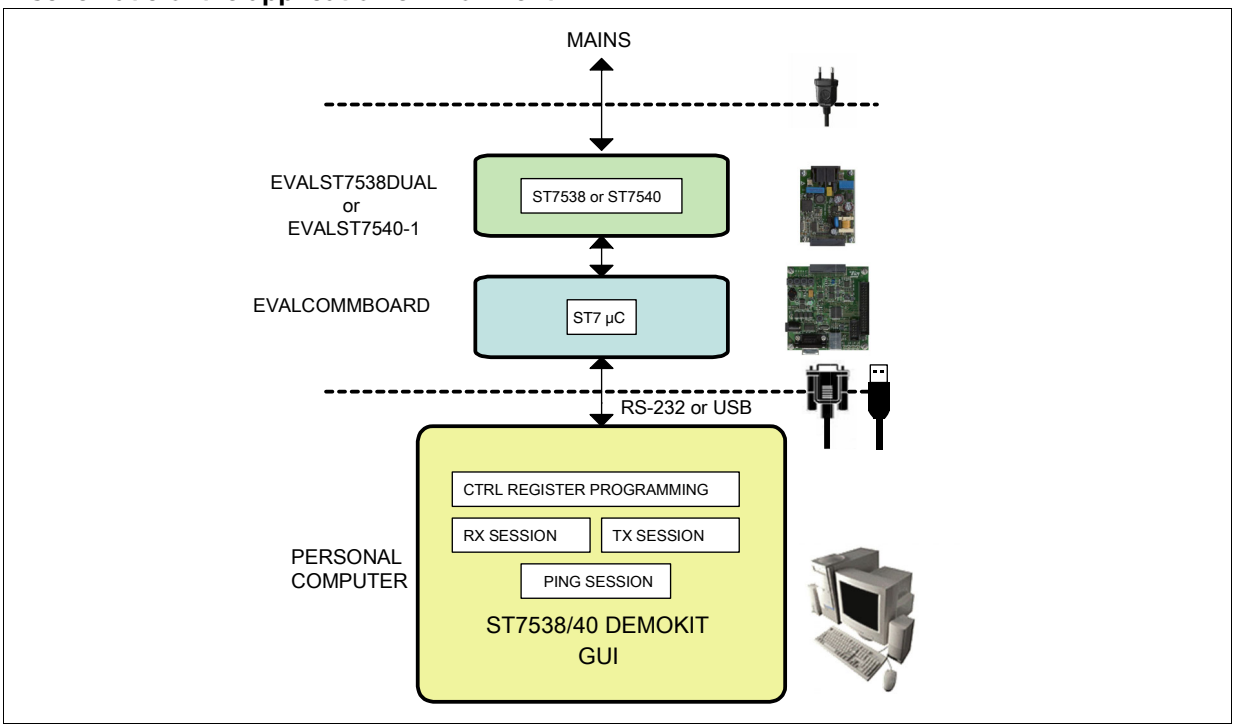
Introduction

The "ST7538/40 FSK Power Line Modem Demo Kit" is a software tool that allows interfacing one or more ST Power Line Modem (PLM) Demo Boards with a Personal Computer. Only PLM Demo Boards equipped with ST7538 and ST7540 devices are supported.

The typical Application Environment consists of a PC that communicates, through a ST7 microcontroller placed on a general purpose board called "EVALCOMMBOARD" (see *Section 1.5*), with a Power Line Modem Board equipped with ST7538 or ST7540 products as shown in *Figure* . The interface used to communicate between the PC and the EVALCOMMBOARD is the RS-232 (USB interface will be supported in future). At start-up, the Software recognizes automatically which type of device is connected to PC and modifies its appearance differently for the ST7538 or the ST7540.

This document describes the ST7540 operating mode (see *Section 1.5*).

A schematic of the application environment



With the "ST7538/40 FSK Power Line Modem Demo Kit" it is possible to:

- Write/read ST7540 (or ST7538) Control Register
- Open a Tx session
- Open a Rx session
- Open a Ping session (minimum two devices required)

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1 Installation information

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1.2 System requirements

A Personal Computer (PC) including:

- one or more RS-232 serial ports
- a CD-ROM reader
- a Hard Disk with at least 20 MBytes of free space
- Screen resolution 800x600 or higher
- Operating System Windows NT/2000/XP
- Adobe Acrobat Reader release 4.0 or more recent

1.3 Installing the software

To install the software:

1. Insert the ST7538/40 Demo Board CD-ROM in your PC and execute the **setup.exe** file.
2. Follow the instructions displayed by the application wizard.

To run the software:

1. Execute the ST7538/40 PLM Demo Kit program (Start →Programs →ST7538_40 FSK PowerLine Modem Demo Kit →ST7538_40 FSK PowerLine Modem Demo Kit).

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1.4 Release information and boards supported

This document refers to Release 3.19 of the "ST7538/40 FSK PowerLine Modem Demo Kit".

The following Evaluation Boards are supported by the "ST7538/40 FSK PowerLine Modem Demo Kit":

- ST7538 Evaluation Board rev. 2.1 & rev. 2.2
- EVALCOMMBOARD rev. 1.1 + EVALST7538DUAL rev. 3.1 Dual Channel
- EVALCOMMBOARD rev. 1.1 + EVALST7540-1 rev. 2.1

1.5 Reference documents

For more information about the EVALCOMMBOARD please refer to "UM0240 User Manual Industrial Communication Board - EVALCOMMBOARD"

For ST7538 working mode, please refer to "UM0241 User Manual ST7538 Power Line Modem Demokit GUI".

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2 Commonly used terms

Table 1 describes some of the commonly used terms regarding Power Line Communication and other terms used in this document:

Table 1. Commonly used terms

Term	Description
FCS	**F**rame **C**heck **S**equence. An error detection scheme that uses parity bits generated by polynomial encoding of digital signals.
FEC	**F**orward **E**rror **C**orrection. A system of error control for data transmission wherein the receiving device has the capability to detect and correct any character or code block that contains less than a predetermined number of symbols in error. FEC is accomplished by adding bits to each transmitted character or code block, using a predetermined algorithm.
MAC	**M**edium **A**ccess **C**ontrol. A service feature or technique used to permit or deny use of a communication medium.
Mains	The electrical network that supplies homes and businesses with power.
Ping	Program that measures the time elapsed between the transmission of multiple packets to a remote device and the return to origin (real meaning). In this document, the term *ping* is used to describe a packet exchange process between a Master device and one or more Slave devices, collecting statistical data about the integrity of packets.
PLC	**P**ower **L**ine **C**ommunication. Communication performed between two or more nodes of the electrical network.
PLM	**P**ower **L**ine **M**odem. A device able to transmit and receive information across the electrical network. To ensure reliability of communication, digital data are transformed modulating a carrier signal in transmission and demodulating such a carrier in reception.

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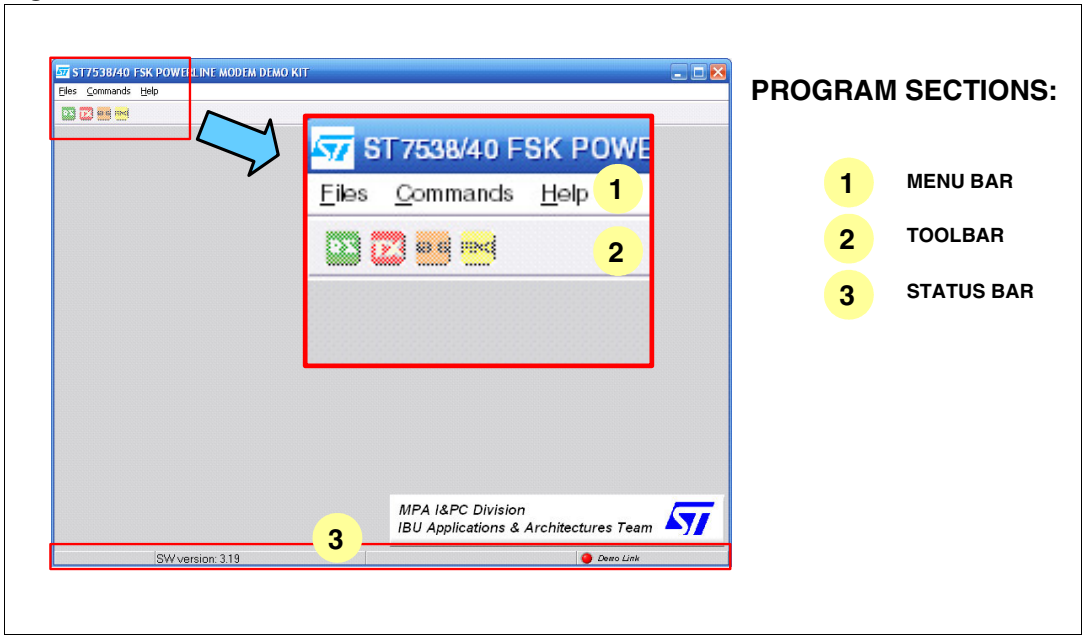
3 User interface

Figure 1 shows the main window of the "ST7538/40 FSK PowerLine Modem Demo Kit" program.

Figure 1. Main window



The Main Window consists of:

1. A menu bar
2. A toolbar
3. A status bar

The following sections provide a complete description for each component.

3.1 Menu bar

The Menu Bar enables the user to:

- Select the COM port for communication with the Demo Board
- Modify the size of the Toolbar
- Save the last configuration used when exiting the program (GUI)
- View help and information about this Software and ST7538 and ST7540 devices
- Exit the program

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Table 2 summarizes the list of commands available in the menu bar and their functions:

Table 2. Menu bar commands

Menu voice	Submenu voice	Function
File	Exit	Exits from the Program
Commands	COM settings	Opens COM port selected and begins the communication with the Demo Board (ports available from COM1 to COM4)
	Toolbar size	Selects the size of the toolbar (small, medium or large)
	Save on Exit	On exit saves the current program settings(1)
Help	ST7538 Demo kit GUI User Manual	Opens the *"ST7538 PowerLine Modem Demo Kit GUI- User Manual"*
	ST7540 Demo kit GUI User Manual	Opens this document
	ST7538 Datasheet	Opens ST7538 specification document
	ST7540 Datasheet	Opens ST7540 specification document
	About	Shows information about Software Release

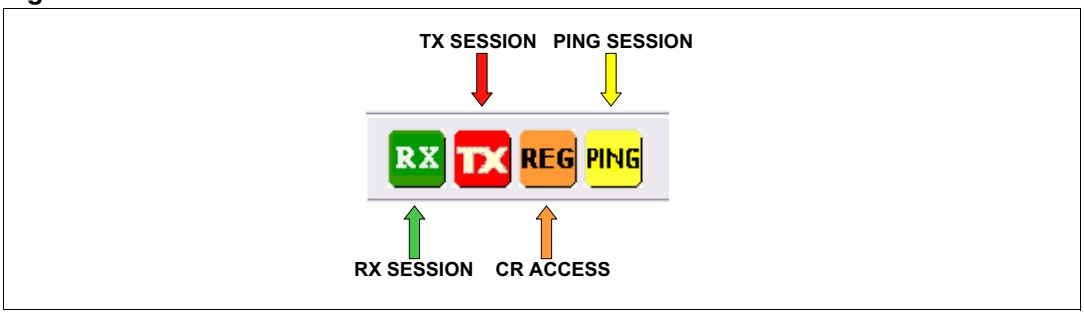
1. Settings saved refer to all controls present in the "ST7538/40 FSK PowerLine Modem Demo Kit" tool.

3.2 Toolbar

The Toolbar is used to access all sections of the program. The sections available are:

- Receiving session
- Transmission session
- Control Register access
- Ping session

Figure 2. Toolbar controls



Toolbar sections are not available until the correct COM port is selected as described in *Section 4.1: Selecting the COM port on page 13*.

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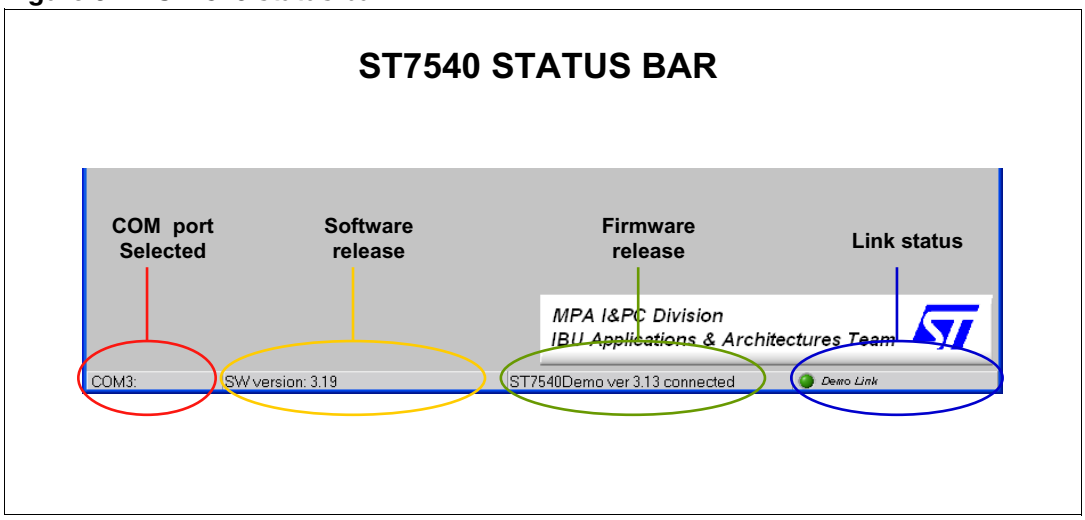
3.3 Status bar

The Status Bar shows information about software, firmware and about the link between PC and the Evaluation Board.

Figure 3. ST7540 status bar



The left side of the Status Bar indicates the selected COM port by means of Command→ COM Settings menu voice. The SW version field indicates the software release. To the right, a text string shows the device used (ST7540 in this case) and the the Firmware release of ST7 microcontroller equipped on IBU Communication Board. The LED to the right of the Status Bar (Demo Link) indicates the status of communication between PC and Evaluation board. If a communication error occurs (bad or no response from the MCU to PC), this LED turns from green to red.

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4 Getting started

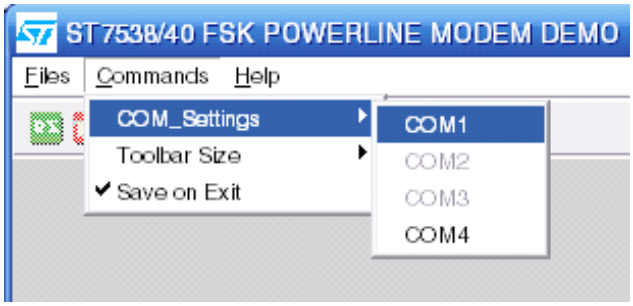
4.1 Selecting the COM port

The first step required for using the PLM Demo Kit program is to select the correct COM port for communication between the PC and the ST7538/40 PLM Demo Board and the ST7 MCU EVALCOMMBOARD.

Warning: **When running the program for the first time, the user must perform a Control Register Writing operation before being able to access the other GUI sections.**

This action is mandatory because the only communication interface available from the MCU on EVALCOMMBOARD to ST7540 is synchronous, while the default Mains interface of ST7540 is asynchronous. The only action that can be performed before a Control Register Writing is a Control Register Reading, because Control Register Access is always synchronous.

Figure 4. COM selection



Once the correct COM port is selected, the program starts communication with the EVALCOMMBOARD and automatically recognizes the type of device (ST7538 or ST7540) on the PLM Board and the firmware revision of the ST7 microcontroller (on EVALCOMMBOARD). The status bar also displays this data as shown in *Figure 3*.

If a communication problem occurs during COM selection, e.g. if the Demo Board has not been properly connected to PC, a message box appears and the user must select the device to manage (see *Figure 5*). The user must select the ST7540 device to ensure correct program behavior (see *Note 1*).

It is possible to control a maximum of four devices (from COM1 to COM4) using a single Personal Computer by launching four instances of the program. In order to identify the instances, a different window background color is used for every COM port. After the COM selection, the user can access all GUI sections.

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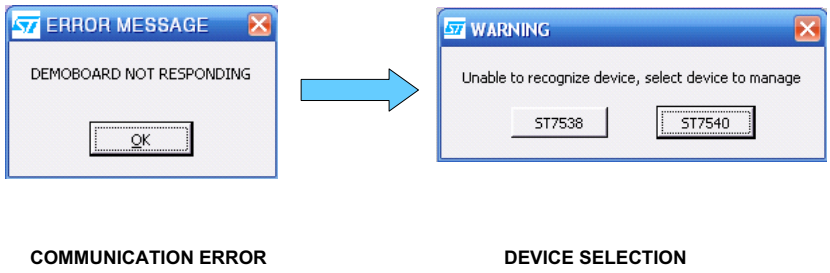
Figure 5. Device selection and communication error during COM selection



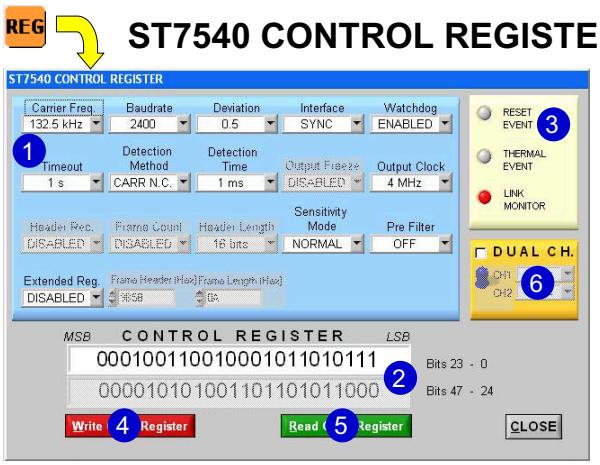
Communication errors can occur at any time. The Device Selection message box appears if an error occurs only during the first COM selection. To ensure reliable communications, a link status LED is present on the Status Bar as shown in *Figure 3*.

Note: 1 If an incorrect device is selected, the user must close and restart the Program in order to avoid undesired behavior.

4.2 Setting the Control Register parameters

To access to the ST7540 Control Register, click the REG button on the Toolbar. The main window then displays the Control Register dialog box as shown in *Figure 6*.

Figure 6. Control Register window



1. Control Register Params Panel
2. WR Control Register String
3. Events Panel
4. Write CR Button
5. Read CR Button
6. Dual channel selection

This dialog box enables the user to modify the Control Register parameters.

Certain parameters may only be modified by enabling the Extended Control Register bit of the Control Register. For more information about the Extended Control Register bit, see *Section 4.2.14: Extended control register on page 19*.

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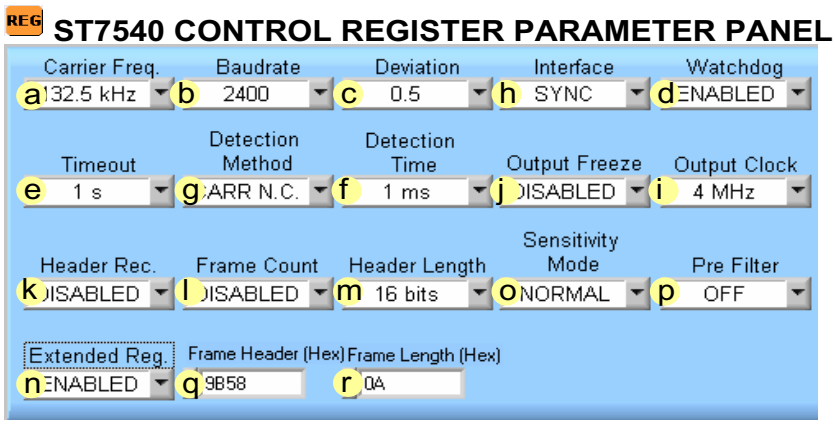
Figure 7. ST7540 Control Register parameters



This section describes each of the Control Register parameters. *Table 3* provides a summary of each parameter, bit-by-bit, as appears in the Control Register string in binary format from MSB to LSB.

Table 3. Summary of Control Register parameters

Bits	Parameter	Bits	Parameter
2:0	Carrier Frequency	17	Output Voltage Freeze (1)
4:3	Baudrate	18	Header Recognition (1)
5	Deviation	19	Frame Length Count (1)
6	Watchdog	20	Header Length (1)
8:7	Transmission Timeout	21	Extended Control Register
10:9	Frequency Detection Time	22	Sensitivity Mode
11	Not used	23	Pre-filter
13:12	Detection Method	39:24	Frame Header (1)
14	Mains Interfacing Mode	47:40	Frame Length (1)
16:15	Output Clock		

1. Available only when Extended Control Register is enabled.

Note: Default values listed in this section refer to the ST7540 Power Line Transceiver.

4.2.1 Carrier Frequency

The Carrier Frequency parameter (Bits [2:0]) defines at which center frequency the signal is transmitted or received across the mains.

If Dual Channel feature is disabled, the Carrier Frequency parameter must be set through the "ST7540 Control Register Parameter Panel". Otherwise, the "Dual Channel Selection" panel must be used. For more information, see *Section 4.3: Selecting the Dual Channel option on page 21*.

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Table 4. Carrier frequency

Bits 2 to 0 (MSB to LSB)	**Value (kHz)**	**Bits 2 to 0** (MSB to LSB)	**Value (kHz)**
000	60	100	82.05
001	66	101	86
010	72	110	110
011	76	111	132.5 (default)

4.2.2 Baudrate

The Baudrate parameter (Bits [4:3]) defines the speed of communication.

Table 5. Baudrate

Bits 4 to 3 (MSB to LSB)	**Value (bps)**	**Bits 4 to 3** (MSB to LSB)	**Value (bps)**
00		10	2400 (default)
01	600	11	4800

4.2.3 Deviation

The Deviation parameter (Bit 5) defines the frequency difference between the mark and the space frequency. When set to “0.5”, the difference is one-half the Baud Rate value. Otherwise, the difference is the Baud Rate value itself.

Table 6. Deviation

Bit 5	**Value**
0	“0.5“ (default)
1	“1“

4.2.4 Interfacing mode

The (Mains) Interfacing mode (Bit 14) defines, when transmitting or receiving data across the Mains, if the timings are managed by ST7540 by means of CLR/T line (Synchronous mode) or by the host (Asynchronous mode).

In Asynchronous mode, data enter directly in the FSK modulator in Transmission mode and are sent directly from the demodulator to the RxD line in Reception mode.

In the current software/firmware release, only Synchronous interfacing mode is available. Due to the fact that Asynchronous Mains interfacing mode is the ST7540 default value, the user must write at least once to the CR (in Synchronous interface mode) before the GUI will perform any other action (except CR reading).

Table 7. Mains interfacing mode

Bit 14	**Value**
0	Synchronous
1	Asynchronous (default)

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4.2.5 Watchdog

The Watchdog parameter (Bit 6) enables the Watchdog function that generates an internal and external reset when the internal Watchdog timer expires. The Watchdog timer is reset by applying a negative pulse on pin WD.

Note: The ST7 MCU Firmware (on EVALCOMMBOARD) automatically provides the Watchdog Timer Reset.

Table 8. Watchdog

Bit 6	Value (sec)
0	Disabled
1	1.5 (default)

4.2.6 Transmission timeout

The Transmission Timeout parameter (Bits [8:7]) defines the maximum time of continuous transmission before a Timeout event occurs. In this case, the transmission is interrupted and the device is set in RX mode.

Table 9. Transmission timeout

Bits [8:7]	Value (sec)	Bits [8:7]	Value (sec)
00	Disabled	10	3
01	1 (default)	11	Not used

4.2.7 Detection method

The Detection method (Bits [13:12]) defines the way the modem notifies the presence of a carrier (CD) or preamble (PD) through the ST7540 CD/PD pin. If the Carrier detection method is selected, the CD/PD line becomes active when a signal with a harmonic component close to the programmed Carrier Frequency is detected on the RAI pin. If the Preamble detection method is selected, the CD/PD line becomes active when a signal with a carrier modulated at the programmed Baud Rate for at least 4 consecutive symbols ("1010" or "0101") is detected on the RAI pin. If the Detection method is conditioned CLR/T and RxD signals are enable only when CD/PD line is enable, otherwise CLR/T and RxD are always enabled.

Table 10. Detection method

Bits [13:12]	Value	Bits [13:12]	Value
00	Preamble detection without conditioning	10	Carrier detection without conditioning (default)
01	Preamble detection with conditioning	11	Carrier detection with conditioning

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4.2.8 Frequency detection time

This parameter (Bits [10:9]) defines the time within which a carrier must be detected across the Mains before signalling it on ST7540 CD/PD pin. If the Preamble Detection method is selected, the CD/PD becomes active only if also a preamble is detected.

For more information, see *Section 4.2.7: Detection method*.

Table 11. Frequency detection time

Bits [10:9]	Value (msec)	Bits [10:9]	Value (msec)
00	0.5	10	3
01	1 (default)	11	5

4.2.9 Output voltage freeze

The Output Voltage Freeze parameter (Bit 17) turns off the Voltage Control Loop once the ALC remains in a steady condition for about 3 control loop periods and maintains a stable condition until the end of transmission.

This function is available only if the Extended Control Register parameter (Bit 21) is enabled.

Table 12. Output voltage freeze

Bit 17	Value
0	Enabled
1	Disabled (default)

4.2.10 Output clock

The Output Clock parameter (Bits [16:15]) sets the ST7540 MCLK line frequency as a sub-multiple of the 16-MHz oscillator frequency or disables the output clock.

Table 13. Output clock

Bits [16:15]	Value (MHz)	Bits [16:15]	Value (MHz)
00	16	10	4 (default)
01	8	11	Clock OFF

4.2.11 Header recognition

The Header Recognition parameter (Bit 18) enables the hardware recognition of one or more headers (one 16-bit header or two 8-bit headers depending on the Header Length parameter setting). Header recognition is signaled by the CD/PD line in different ways depending on Frame Length Count (bit 19).

Note: If synchronization software is used, this parameter must be disabled to ensure the correct behavior of RX sessions.

This function is available only if the Extended Control Register parameter (Bit 21) is enabled.

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Table 14. Header recognition

Bit 17	Value
0	Disabled (default)
1	Enabled

4.2.12 Frame length count

Frame Length Count parameter (Bit 19) is related to the Header Recognition function.

If enabled, receiving data are put on RxD line and CLR/T becomes active only after a header recognition and only for the number of (16-bit) data words indicated by the Frame Length parameter (Bits [47:40]).

Header Recognition is signaled to the host through the CD/PD line that is held low during RxD and CLR/T activation.

If the Frame Length Count parameter is disabled, the header recognition is signaled by forcing down the CD/PD line for one CLR/T line period while lines RxD and CLR/T are always active.

This function is available only if the Extended Control Register parameter (Bit 21) is enabled.

Table 15. Frame Length Count

Bit 19	Value
0	Disabled (default)
1	Enabled

4.2.13 Header length

The Header Length parameter (Bit 20) is related to Header Recognition function and defines the length of the header to recognize (8 or 16 bits).

If an 8-bit header is selected, two headers can be used since the Frame Header parameter (Bits [39:24]) consists of 16 bits.

This function is available only if the Extended Control Register parameter (Bit 21) is enabled.

Table 16. Header Length

Bit 20	Value
0	8 bits
1	16 bits (default)

4.2.14 Extended control register

The Extended Control Register parameter (Bit 21) enables the extended functions: Output Voltage Freeze and Header Recognition. If enabled, 24 or 48 bits can be transmitted to the ST7540 (the software always transmits 48 bits when enabled).

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Table 17. Extended control register

Bit 21	Value
0	Disabled (default)
1	Enabled

4.2.15 Sensitivity mode

The Sensitivity Mode parameter (Bit 22) defines the low threshold for the FSK demodulator block.

Table 18. Sensitivity mode

Bit 22	Value
0	Normal Sensitivity (500 µVrms) (default)
1	High Sensitivity (250 µVrms)

4.2.16 Pre-filter

The Pre-filter parameter (Bit 23) enables a pre-filter on the Reception path.

Table 19. Pre-filter

Bit 23	Value
0	Disabled (default)
1	Enabled

4.2.17 Frame header

The Frame Header (Bits [39:24]) defines the Header to recognize when the Header Recognition function is enabled. It can consist of one 16-bit header or by two 8-bit headers depending on the Header Length value (Bit 20).

This function is available only if the Extended Control Register parameter (Bit 21) is enabled.

Table 20. Pre-filter

Bits [39:24]	Value
MSB--LSB	From 0x0000 to 0xFFFF
Default	0x9B58

4.2.18 Frame length

This parameter (Bits [47:40]) defines the number of data, expressed in 16-bit words (e.g. Frame Length equal to "1" →16 bits), to send to the Host Controller on the RxD line when the Header Recognition and Frame Length Count parameters are enabled and a Header has been detected.

This function is available only if the Extended Control Register parameter (Bit 21) is enabled.

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Table 21. Frame length

Bits [47:40]	Value
MSB--LSB	From 0x00 to 0xFF
Default	0x80

4.2.19 Limitations on Control Register parameters

Certain parameters are limited during programming because either their functions are not supported by the tool (software limitations) or because they depend on other Control Register parameters (hardware limitations). *Table 22* lists these limitations.

Table 22. Limitations on control register parameters

Parameter	Limitation
Interface mode	SW limitation: Only Synchronous Mains interface mode is supported by SW tool
Output Voltage Freeze	HW limitation: Available only if Extended Control Register Bit is enabled
Header Recognition	HW limitation: Available only if Extended Control Register Bit is enabled
Frame Length Count	HW limitation: Available only if Extended Control Register Bit is enabled
Header Length	HW limitation: Available only if Extended Control Register Bit is enabled
Frame Header	HW limitation: Available only if Extended Control Register Bit is enabled
Frame Length	HW limitation: Available only if Extended Control Register Bit is enabled

4.3 Selecting the Dual Channel option

Certain ST7540 PLM Demo Boards[a] have the ability to select the central frequency of external coupling filter between two operating frequencies.

In order to activate this function, the user must select the DUAL CH. check box in the Dual Channel selection pane, set the correct frequencies for each of the two channels. When Dual Channel function is enabled, a command of channel selection is transmitted each time the user pushes the **Write Control Register** button.

When the Dual Channel feature is enabled, the Control Register is programmed according to the selected Dual Channel frequency.

a. PLM Eval Boards that support the Dual Channel feature have the suffix "DUAL" (i.e. "EVALST7540DUAL Rev. x.x")

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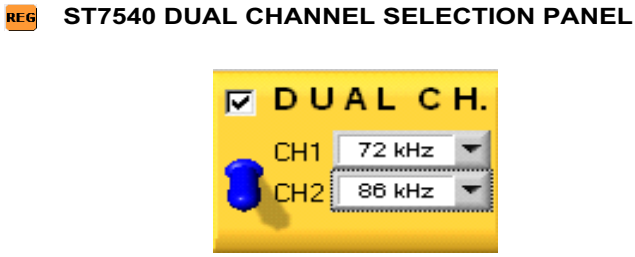
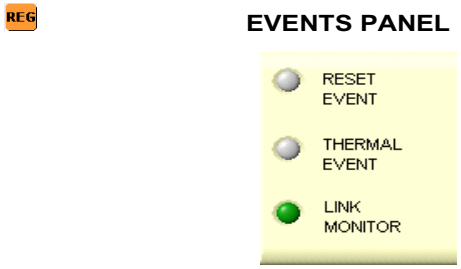
Figure 8. Dual channel selection panel



4.4 Monitoring events

By means of Events Panel LEDs it is possible to monitor the status of the Demo Board. The LEDs represent events occurred during the working session.

Figure 9. Events panel



The LEDs are updated every time a communication is performed between the software tool and the Demo Board, except for the Link Monitor LED that it is activated also when the user modifies a Control Register parameter using the Control Register Parameters Panel. In this case, the Write Control Register String on the panel no longer corresponds to the ST7540 Control Register. For this reason, the Link Monitor LED is always enabled (red) at first run of the program.

Table 23 lists possible events.

Table 23. Summary of events

Event	Description
Reset event	Event occurs when MCU of IBU Communication Board has been reset
Thermal event	Event occurs when a Thermal shutdown event has occurred
Link monitor	Event occurs when: – *Write Control Register String* does not correspond to ST7540 Control Register – A reset or a communication problem event occurs

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If a communication problem occurs, a message box describing the issue appears. In this case, the user must try again to perform the same operation that caused the problem until no more message boxes appear and the Link Monitor LED becomes green.

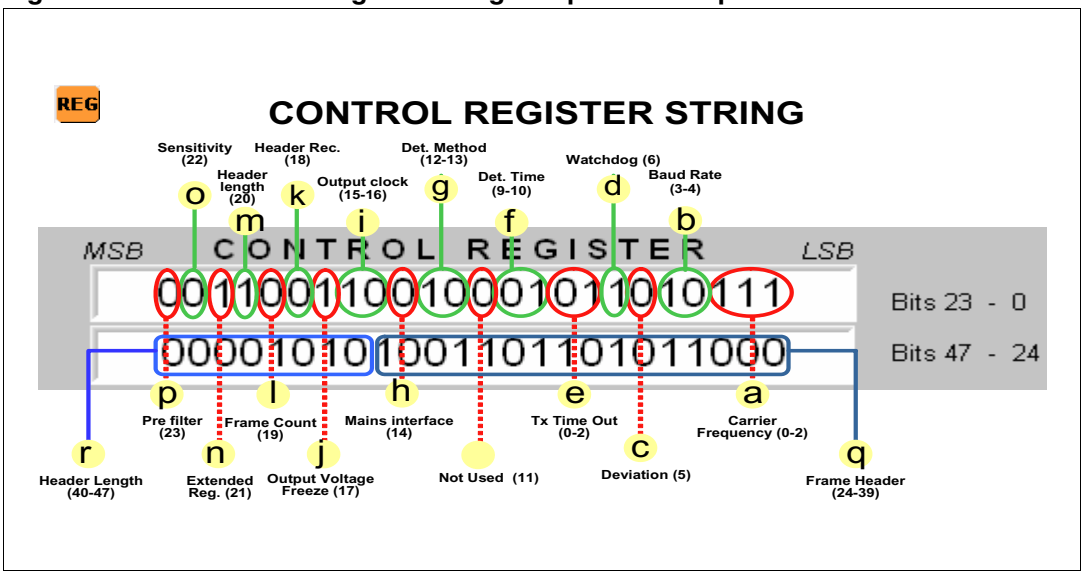
Note: If communication problems persist, the user can reset the microcontroller on EVALCOMMBOARD by pushing the RES button. After this operation, a Control Register Writing or a Control Register Reading must be performed in order to avoid undesired behavior.

4.5 Using the Control Register String

The selected parameter values of the virtual ST7540 Control Register appear in the textbox at the bottom of the Control Register dialog box (*Figure 10*) in binary format from MSB to LSB. When the user modifies or clicks one of the Control Register parameters, the corresponding bits of the Control Register string become red.

If the Extended Register control bit is set to Enabled, the second part of the Control Register string (Bits 47 to 24) becomes active and the extended functions are available.

Figure 10. Write control register string and parameters position



Note: When the Extended Register control bit (bit 21) is set to Enabled, the ST7540 accepts 24- or 48-bit CR strings. The "ST7538/40 FSK Power Line Modem Demo Kit" always writes 48 bits when this bit is enabled.

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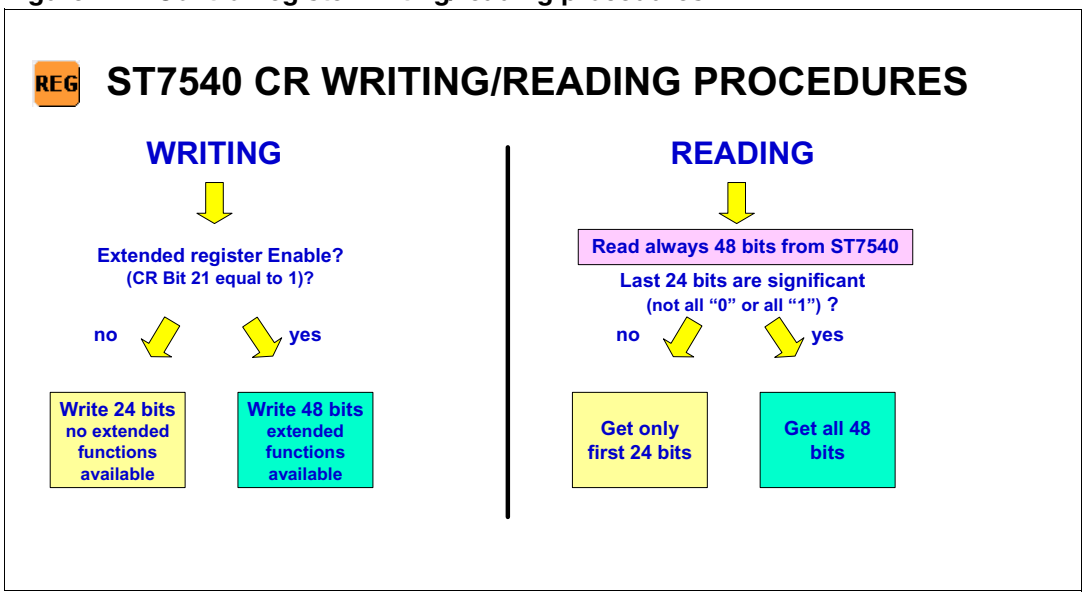
4.6 Reading/Writing Control Register parameters

Figure 11 summarizes the Control Register reading/writing procedures with the PLM Demo Board.

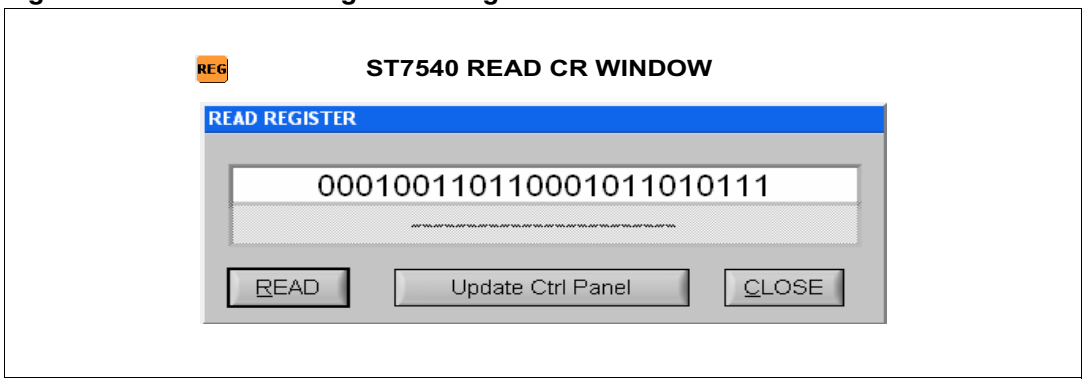
Figure 11. Control register writing/reading procedures



On the Control Register window, click **Write CTRL Register** to transmit the 24- or 48-bit Control Register string to the ST7540 PLM Demo Board.

Click **Read CTRL Register** to read the contents of the Control Register string. This displays the Read Control Register dialog box shown in *Figure 12*.

Figure 12. Read CTRL Register dialog box



If no communication issues occur, the Read Control Register string (which is similar to the Write Control Register string) displays the content of the ST7540 Control Register. Note that 24 or 48 bits are read, depending on parameters Extended Control Register (Bit 21) and Header Recognition (Bit 18).

Click the **Read** button in the Read Control Register dialog box to perform a new reading of Control Register string values. Click the **Update Ctrl Panel** button to update the Control Register parameter values with the 24/48 bits that are read. Click **Close** to close the Read Control Register dialog box.

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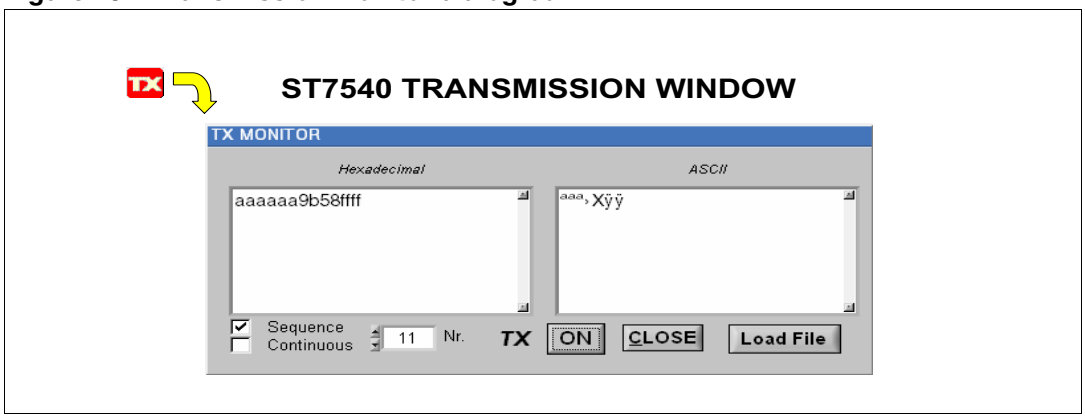
5 Transmission sessions

Click **TX** on the toolbar to open a transmission session and to display the Transmission Monitor dialog box shown in *Figure 13*.

Figure 13. Transmission Monitor dialog box



The textboxes display the content to be sent across the Mains in hexadecimal and ASCII format, respectively.

Transmission methods

Two methods of transmission are available: **Sequence** and **Continuous**.

The Sequence method sends the content of textboxes across the Mains for selected number of times (**Nr.** parameter) with a delay of 200 ms between transmissions. It is important to note that each sequence transmitted is a single transmission session to ensure that no Timeout issues occur if the message to transmit is not too long.

The Continuous method sends the content of the textboxes repeatedly across the Mains in a single transmission until the transmission is interrupted by the user or by a Timeout event.

Note: A maximum of 127 bytes can be transmitted to the MCU.

Transmitting data

On EVALCOMMBOARD, the orange DL4 LED is turned on when a transmission begins. When a Timeout Event occurs, the red DL2 LED is turned on.

Click **ON** to transmit the content of textboxes (that represents the data to be sent in both hexadecimal and ASCII format) across the Mains.

Click **Load File** to load an ASCII or HEX text file in the textbox.

Click **Close** to close the Transmission Monitor dialog box.

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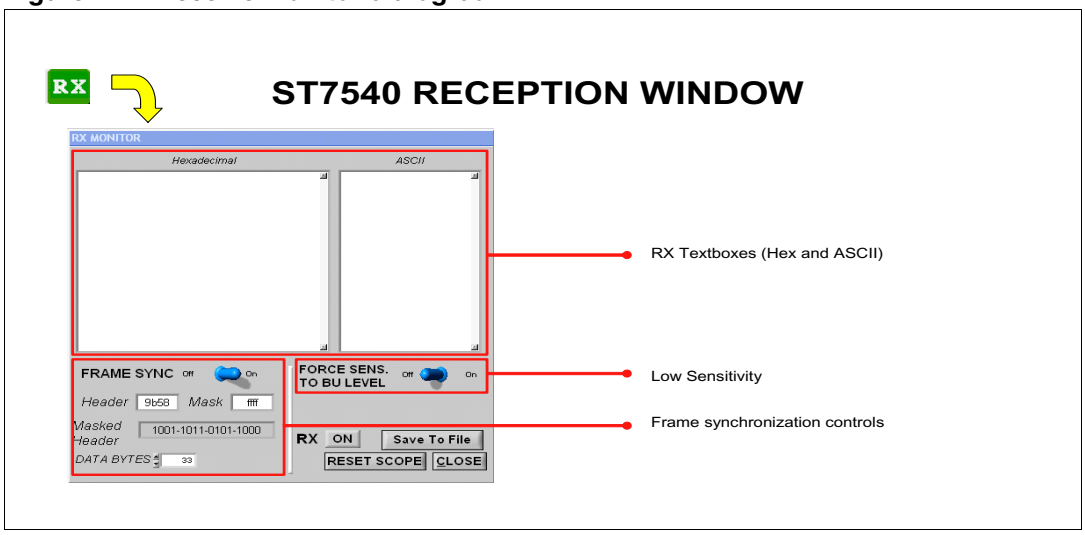
6 Receive sessions

Click **RX** on the toolbar to open a receiving session and to display the Receive Monitor dialog box shown in *Figure 14*.

Figure 14. Receive Monitor dialog box



The textboxes display the content of the incoming data in hexadecimal and ASCII format, respectively. To clear the Hexadecimal and ASCII textboxes, click **Reset Scope**.

Frame synchronization and Header data

As it is not possible to know when the ST7540 starts to demodulate data incoming from the mains, a Frame Synchronization feature can be enabled in order to know when the data flow begins.

If the Frame Synchronization feature is enabled (**Frame Sync** toggle switch), the data flow from the ST7540 is filtered from the MCU and the data is sent to the PC only when a header (defined by the **Header** parameter) is recognized. This ensures that all following bytes are correctly sent to PC if the transmitted message is preceded by a preamble (i.e. 0xAAAA or 0x5555) and by a header (i.e. 0x9B58).

To mask the Header, enter the corresponding hexadecimal value in the **Mask** textbox. This feature enables the use of less than 16 bits or more than one header. The **Masked Header** textbox displays the masked header.

The **Data Bytes** parameter selects how many bytes the MCU must transmit to the PC after a header recognition when in Frame Sync mode.

If frame synchronization is not required, the user can switch OFF the **Frame Sync** feature and data are sent directly from the ST7540 to the PC. Note that since the first data demodulation time is unpredictable, byte synchronization is not ensured.

Sensitivity modes

In addition to two sensitivity modes selectable through the Control Register Sensitivity Mode (see *Section 4.2.15: Sensitivity mode*), it is possible to force ST7540 sensitivity to the BU

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level (about 83.5 dBµVrms) by selecting the **Force Sens. to BU Level** parameter. When enabled, the TxD line is forced to "1"; thus obtaining a lower sensitivity.

Note: If synchronization software is used, Control Register Header Recognition (Bit 18) must be set to "0" in order to have a proper behavior of the RX session. For more information, see *Section 4.2.11: Header recognition on page 18**.*

Receiving data

On EVALCOMMBOARD, the green DL3 LED is turned on in Receive mode.

Two reception methods are available: Reception with synchronization or Reception without synchronization depending on the **Frame Sync** parameter setting.

Click **ON** to start receiving data. Click **Close** to stop data reception.

Saving data

In order to save data received from the Mains in a text file (in either hexadecimal or ASCII format), click **Save to File** before clicking **ON** to start receiving incoming data. The maximum file size allowed is 64 KBytes. To stop saving data, click **Stop Saving**.

Click **Close** to close the Receive Monitor dialog box.

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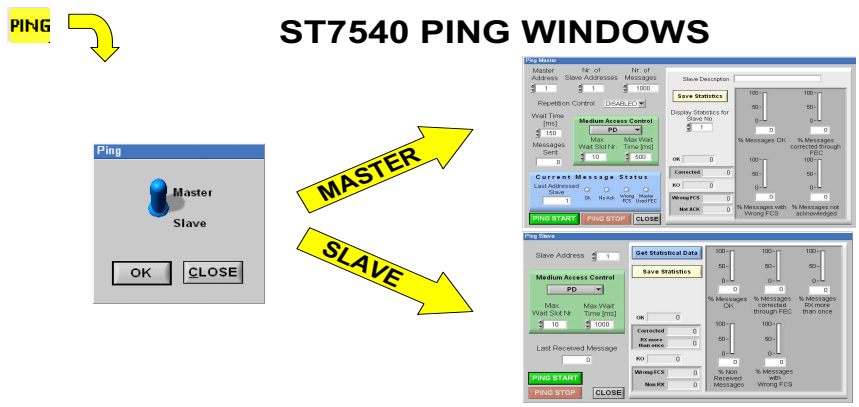
7 Ping sessions

In order to evaluate the reliability of a communication between two or more devices, a Ping session can be performed. A ping session consists of a Master that sends a sequence of messages to one or more Slaves. If the messages are correctly received by Slaves, they are re-sent to the Master enabling the application to collect a wide variety of statistical data. An error correction algorithm is also included.

Click **PING** on the toolbar to open a Ping session. First select **Master** or **Slave** to set the device in the desired mode and to display the corresponding dialog box shown in *Figure 15*.

Figure 15. Ping windows



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7.1 Opening a Ping Master session

7.1.1 Ping Master parameters

As shown in *Figure 16*, *Table 24* following parameters can be selected for the Master device and the ping session.

Figure 16. Ping Master dialog box

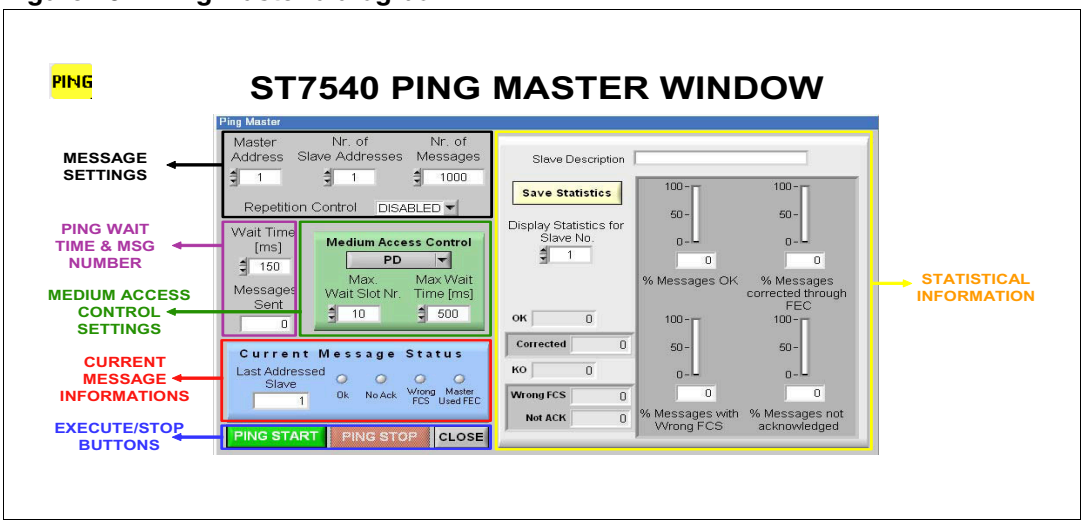

Table 24. Ping master parameters

Parameter	Description
Message settings	
Master address	Defines the Address (from 1 to 255) of the Master device.
Nr. of slave addresses	Defines the Number (from 1 to 255) of Slave devices. Slave Addresses start from 1 to *Nr. of Slave Addresses*.
Nr. of messages	Defines the total number of messages to send to Slave devices. The messages are numbered from 0 to *Nr. of Messages*. (Message “0” is used only to reset Slave statistical data).
Repetition control	Repetition can be used to improve reliability of communication. When enable, if a message is not Acknowledged it is sent until three times before to consider it not Acknowledged.
Ping Wait Time and Message Number settings	
Wait time	Defines the maximum wait time to obtain a valid response (with a valid address) from Slave device before considering not Acknowledged the message. The minimum value that can be selected depends on baud rate selected according the round trip time of message transmitted.(1)
Messages sent	Defines the number of last message sent. It goes from 0 to *Nr. of Messages* and it is updated at every new message sent.

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Table 24. Ping master parameters (continued)

Parameter	Description
Medium access control settings	
Medium access control	Defines which type of medium access is used. Choices are “none”, “BU” or “PD”. In the two last settings, packets are sent only if respectively BU or CD/PD lines are not active. If “PD” is selected while “Carrier Detection” CR control is used, content of Control Register is changed in order to select the detection method to “Preamble detection”.
Max wait slot nr.	If BU or CD/PD lines are actives (depending on Medium Access Control selected), the Master waits for a time selected randomly between 4ms and 4**Max Wait Slot Nr.* ms before to analyze if it is possible to transmit a packet.
Max wait time	Defines the maximum time to wait when “BU” or “PD” Medium Access control are selected before to transmit the packet. When the Max Wait Time is elapsed, the packet is transmitted even if BU or CD/PD lines are actives.
Current message settings	
Current message status	Shows information about the acknowledgement of the current message sent. *Last Addressed Slave* represents which Slave is the recipient of message. LEDs show if a message is acknowledged properly (OK), not correctly acknowledged (No Ack.), if the acknowledged message has errors corrected by FEC (Master used FEC) or if the acknowledged message has errors not corrected by FEC (Wrong FCS).
Statistical data display	
Statistical data for Slave	These data are available for each Slave. Enter the name of the Slave device in Slave Description textbox. – *% OK messages:* the total number of messages properly received plus those corrected through FEC – *Corrected messages:* the number of messages corrected through FEC – *KO messages:* the total number of messages with wrong FCS plus the number of message not acknowledged – *Wrong FCS messages:* the number of messages with wrong FCS even after correction – *Not ACK messages:* the number of messages not acknowledged Click **Save Statistics** to store collected data in a text file.

1. Minimum Wait time values are: @600 bps→300 ms, @1200 bps→150 ms, @2400 bps→75 ms, @4800 bps→40 ms.

7.1.2 Starting a Master Ping session

Click **Ping Start** to start the ping session. The MCU on EVALCOMMBOARD continuously transmits the current status of every message transmitted to the PC.

Click **Ping Stop** to end the ping session.

Click **Close** to close the Ping Master dialog box.

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7.2 Opening a Ping Slave session

7.2.1 Ping Slave parameters

As shown in *Figure 17*, *Table 25* following parameters can be selected for the Slave device and the ping session.

Figure 17. Ping slave window

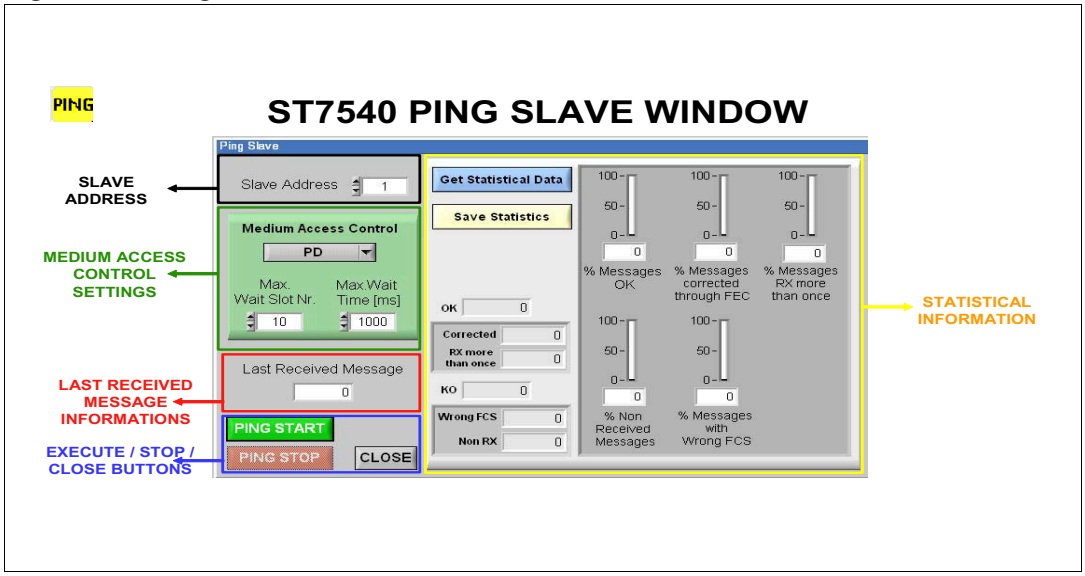

Table 25. Ping slave parameters

Parameter	Description
Slave address settings	
Slave address	Defines the Address (from 1 to 255) of Slave device.
Medium access control settings	
Medium Access Control	Defines which type of medium access is used. Choices are “none”, “BU” or “PD”. In the two last settings packets are sent only if respectively BU or CD/PD lines are not active. If “PD” is selected while “Carrier Detection” CR control is used, content of Control Register is changed in order to select the detection method to “Preamble detection”.
Max Wait Slot Nr.	If BU or CD/PD lines are actives (depending on Medium Access Control selected), the Slave waits for a time selected randomly between 4ms and 4**Max Wait Slot Nr.* ms before to analyze if it is possible to transmit a packet.
Max Wait Time	Defines the maximum time to wait when “BU” or “PD” Medium Access control are selected before to transmit the packet. When the Max Wait Time is elapsed, the packet is transmitted even if BU or CD/PD lines are actives.
Last received message information	
Last Received Message	Shows the number of last message received. This field is updated only when *Get statistical Data* button is pressed.

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Table 25. Ping slave parameters (continued)

Parameter	Description
Statistical data display	
	The following statistical data are collected: – *OK messages:* the total number of messages properly received plus those corrected through FEC – *Corrected messages:* the number of messages corrected through FEC – *RX more than once:* the number of messages received more than once – *KO messages:* the number of message not received – *Wrong FCS messages:* the number of messages with incorrect FCS even after correction – *Not RX messages:* the number of message not received, calculated by subtracting the number of total message received (both the correct and the incorrect ones) from the number of last message received (*Last Received Message* field) Click **Get Statistical Data** to update statistical data. Click **Save Statistics** to store collected data in a text file.

7.2.2 Starting a Slave Ping session

Click **Ping Start** to start the ping session and enable the reception of data.

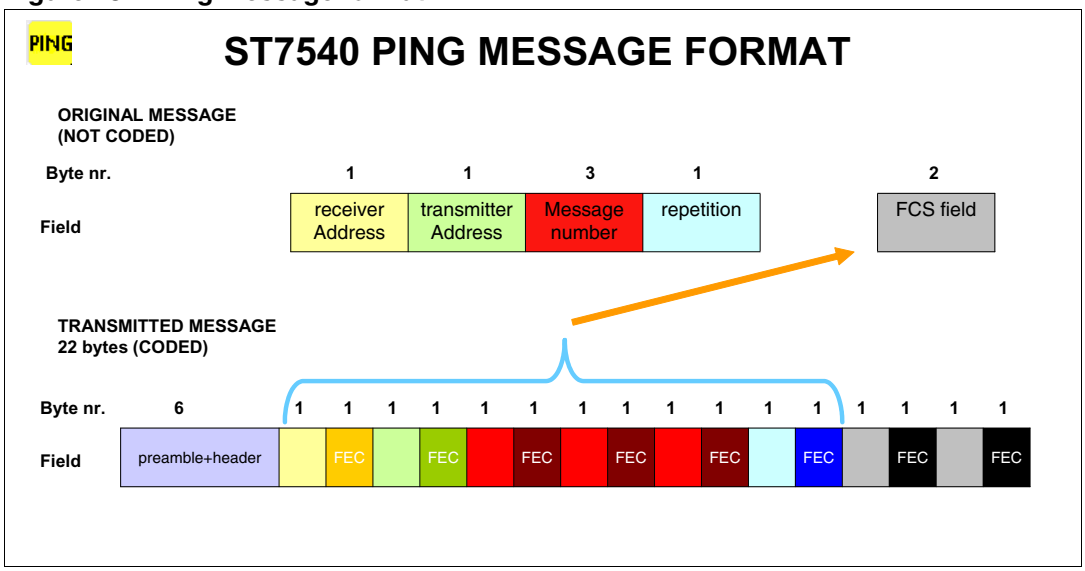
Click **Ping Stop** to end the ping session.

Click **Close** to close the Ping Slave dialog box.

7.3 Ping protocol

The Ping session consists of an exchange of packets between one Master device and one or more Slave devices. *Figure 18* shows the ping message exchange format.

Figure 18. Ping message format



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When the user clicks **PING START**, the session begins and the Master sends a series of packets to one or more Slave devices. All the packets contain the following information:

- Preamble (0xAAAAAAAA): 4 bytes
- Header (0x9B58 for Master packets and 0xE958 for Slave packets): 2 bytes

To improve reliability of communications, a FEC algorithm and one redundant byte is used for each of the following bytes of information:

- Receiver Address: 1 byte (+ 1 byte for FEC)
- Transmitter Address: 1 byte (+ 1 byte for FEC)
- Current Message number: 3 bytes (+ 3 bytes for FEC)
- Repetition (0x00,0x01,0x02 if the same message has been transmitted once, two or three times): 1 byte (+ 1 byte for FEC)
- FCS field, obtained through a calculation of 12 previous bytes: 2 bytes (+ 2 byte for FEC)

The Slave detects, through the Receiver Address field, if the packet is headed for it or not. If the message is directed to it, a FCS operation is performed on 12 bytes following the preamble and the header. The result of calculation is compared with FCS field transmitted from Master. If the two values differ, an attempt of correction is executed (through FEC correction code) and a new comparison is performed. If the two FCS fields match, the message is considered OK from Slave and it is resent to the Master (inverting Master Address with Slave Address and recalculating FEC and FCS bytes). Otherwise, the message is considered KO and no response is performed.

An exception occurs when Master transmits the message zero (with Message Number field 0x000000). This message is used to reset the Slave, statistical data collected and no response to Master is needed.

After a packet transmission, the Master waits (for a time defined in Wait Time in Master Window) the response from Slave, and if a message headed for it is detected it performs the same "correctness detection" operation above described in order to consider the message OK or KO.

Repetition function

To improve the reliability of communications, it is possible to use the repetition function. In this case, if a response is not detected by Master the packet is sent again for a maximum of three times before it is definitively considered Not Acknowledged.

Medium access control

A Medium Access Control is also implemented (for both Master and Slave) in order to prevent two or more devices from transmitting at the same time as described in *Table 24* for the Ping Master parameters and *Table 25* for Ping Slave parameters.

Note: For a low-level description of Ping protocol, please refer to "Power Line Modem Evaluation FW".

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7.4 Ping session flowcharts

Figure 19 and *Figure 20* describe the Master and the Slave loops, respectively, while a ping session is in progress.

Figure 19. Ping master loop

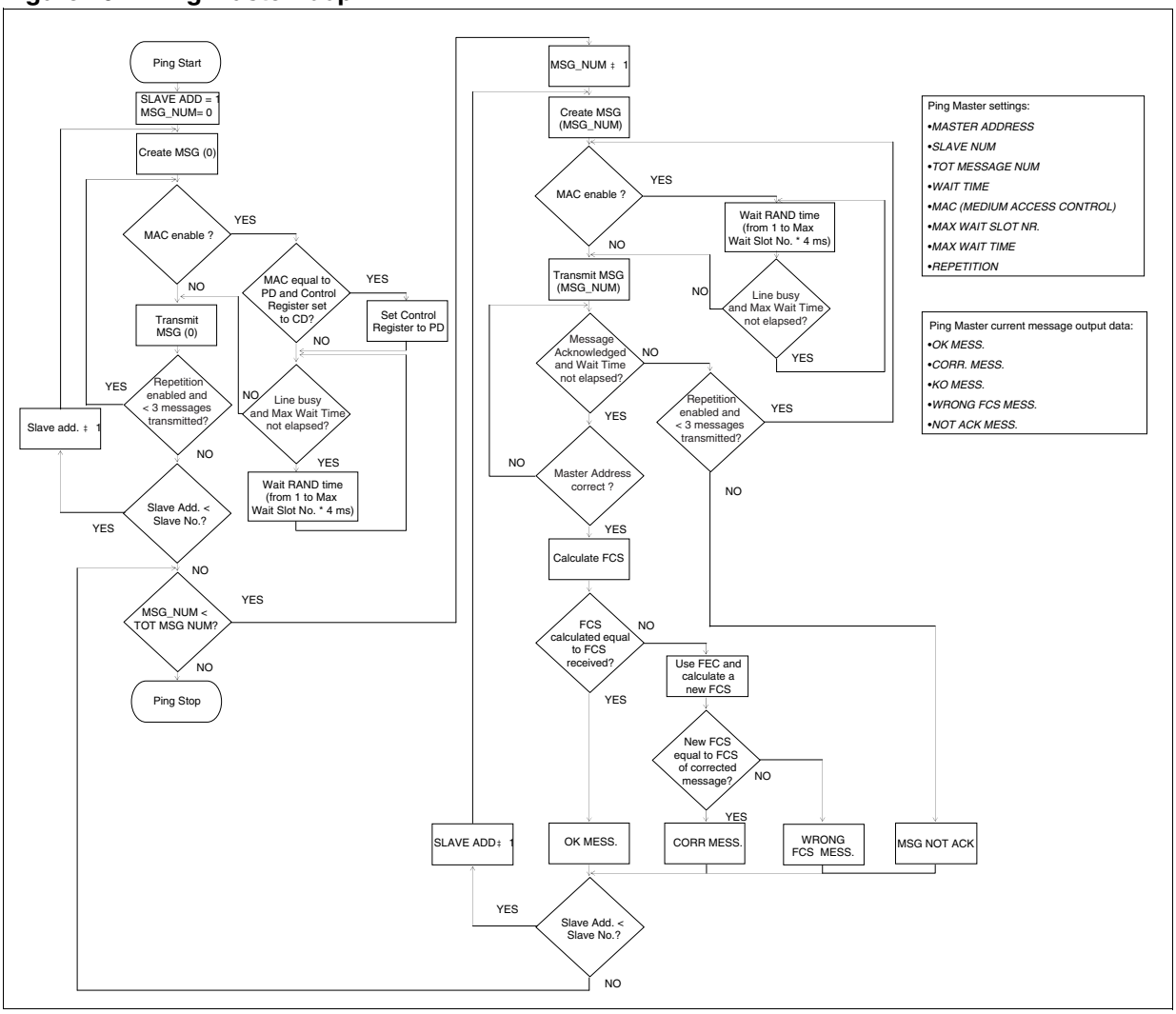

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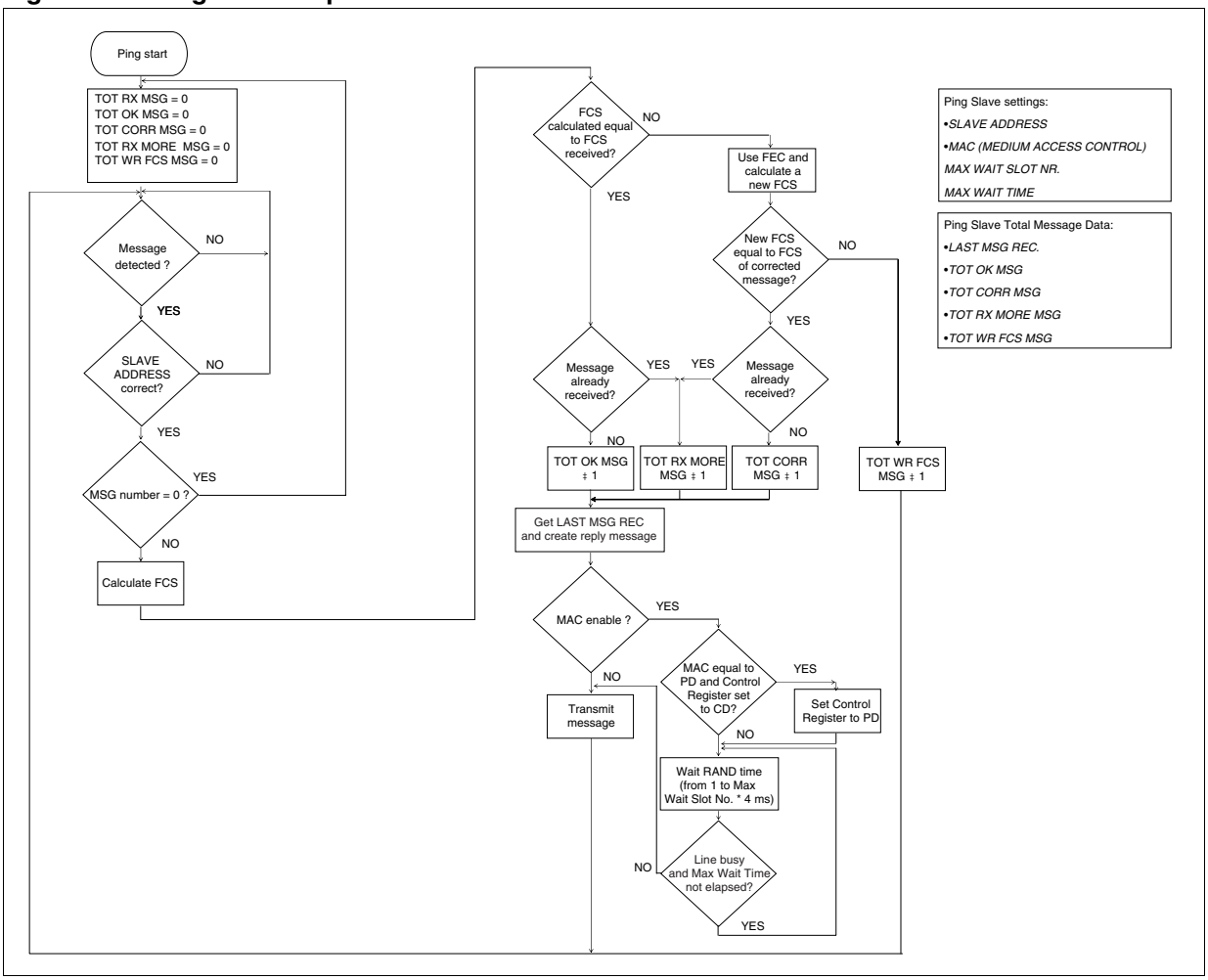
Figure 20. Ping slave loop



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8 Communication session examples

This sections provides examples of some of the most common operations that can be performed with two or more Demo Boards. The operations performed are:

- Communication session without Frame Synchronization
- Communication session with Software Frame Synchronization
- Communication session with ST7540 Frame Synchronization
- Ping session

8.1 Setup procedure

8.1.1 Required hardware

The following hardware is required for these example sessions:

- Two EVALCOMMBOARD rev. 1.1 + EVALST7540-1 rev. 2.1 (76 kHz)
- One PC with two RS-232 ports

8.1.2 Hardware setup

The setup of the communication sessions is common for all tests.

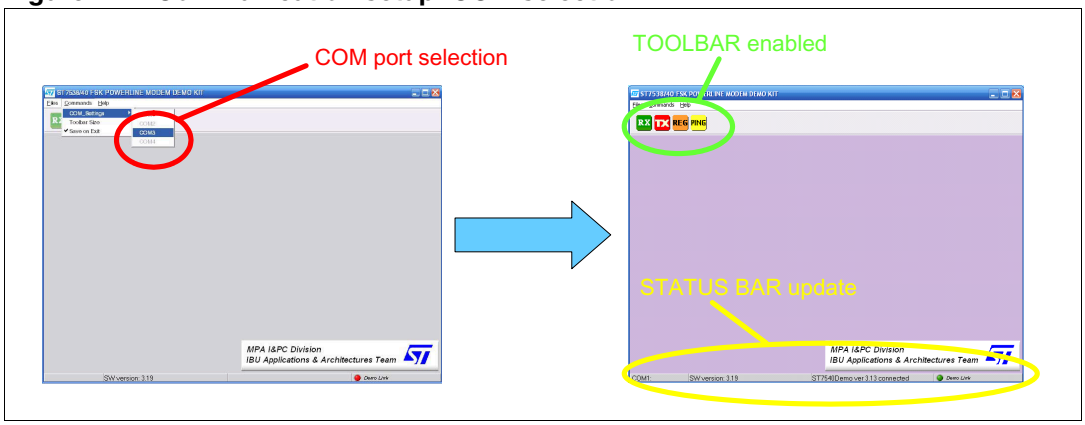
1. Connect the PLM Demo Boards to the EVALCOMMBOARDs.
2. Connect the boards to the two RS-232 PC ports through the serial cables to the PC.
3. Link the PLM Boards to an isolated 110/220V~ Mains voltage.
4. Finally, reset the two EVALCOMMBOARDs by pressing the Reset button.

8.1.3 Software setup

To control two devices at the same time, the user must run two sessions of the program:

1. Open **Start**, **Programs**, **ST7538_40 FSK Power Line Modem Demo Kit** and click **ST7538_40 FSK Power Line Modem Demo Kit**.
2. Then, select the correspondent COM available for every session (in this example COM1 for the first board and COM3 for the second board); enabling the GUI to communicate with each EVAL Board.

Figure 21. Communication setup: COM selection



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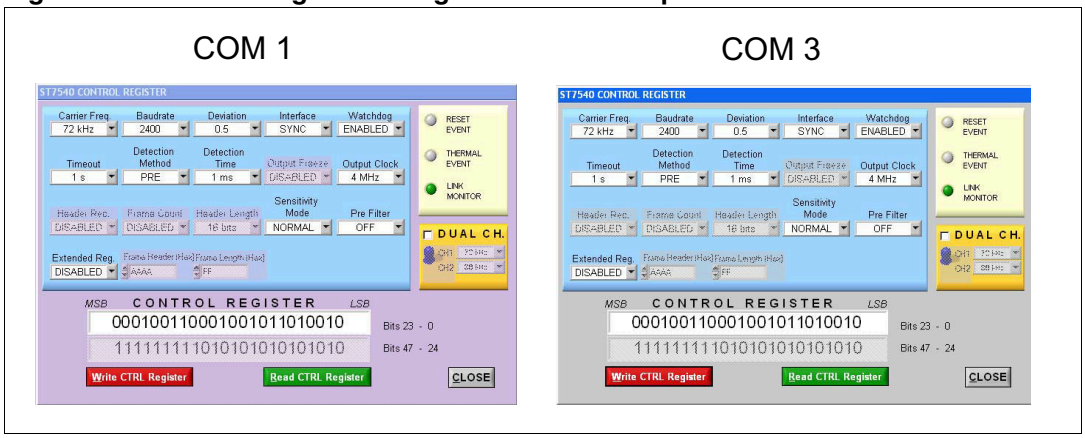
Note: After selecting COM port, the Status Bar is updated showing information about the selected COM port, SW/FW revisions and the Link status.

Before starting a Communication session, the user must perform a Write Control Register for the two windows.

3. Click **REG** on the toolbar to open the Control Register dialog box.
4. Ensure that the **Dual Channel** feature is disabled.
5. Because only few bits change for the sessions in respect to the default Control Register parameters, click **Read CTRL Register** and then **Update CTRL Panel**.
6. Set the **Carrier Frequency** to 72 kHz and the **Detection Method** to Preamble to ensure that the incoming data are received only when a preamble is detected across the Mains.

Now, the two Control Register dialog boxes should appear as shown in *Figure 22*.

Figure 22. Control Register dialog boxes after setup



Once the Control Registers are correctly configured, communication can begin between the boards.

8.2 Communication session without Frame Synchronization

In this example, the board connected to COM1 is used as the Transmitter while the board connected to COM3 is used as the Receiver. Five messages are transmitted across the Mains and the receiving method is not synchronized, so incoming data from ST7540 are sent directly to the PC.

Actions to perform on GUI connected with COM3:

1. Click **Rx** on toolbar to open the Rx Monitor dialog box.
2. Set **FRAME SYNC** to OFF.
3. Click **ON**.

Now the receiving board is waiting incoming data. (It activates itself only when a preamble is detected across the Mains).

Actions to perform on GUI connected with COM1:

1. Click **Tx** on toolbar to open the Tx Monitor dialog box.
2. Write the preamble "AAAAAAAA" in the hexadecimal textbox.

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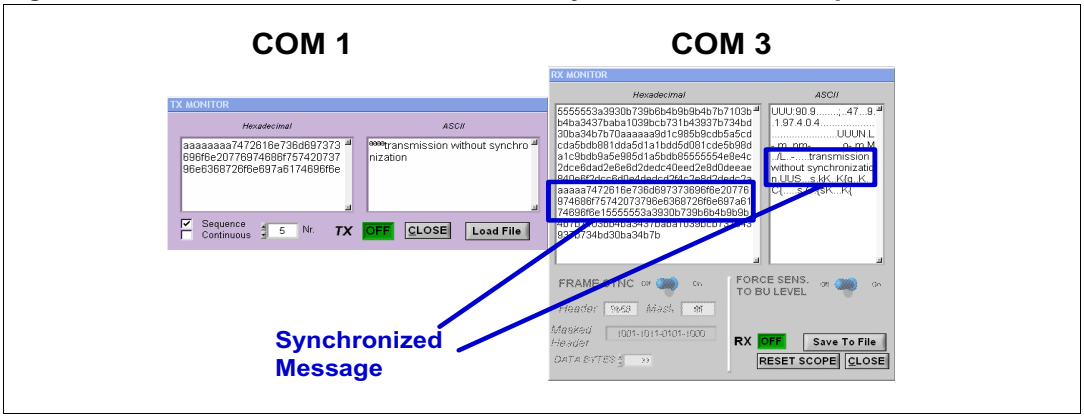
3. Add the text string “transmission without synchronization” in the ASCII textbox.
4. Select **Sequence Mode** and set **Nr.** to “5”.
5. Click **ON**.

Five messages are sent with a temporal distance of 200 milliseconds.

Figure 23. Communication without Frame Synchronization example



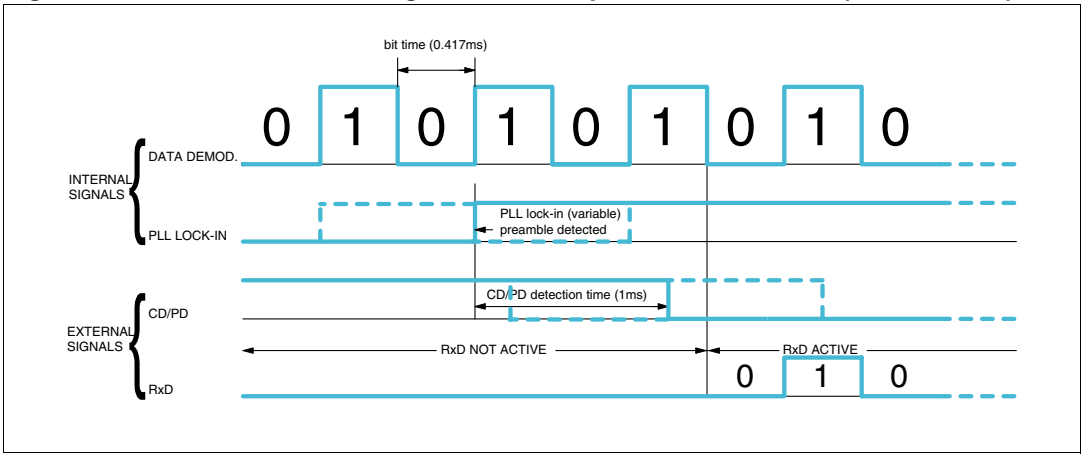
In *Figure 23* (COM3 section), the five transmitted sequences do not appear to be received correctly. This behavior is due to fact that the ST7540 starts writing data on the RX line at different time for every message, because in Synchronous Mode the PLL that provides the CLR/T signal must reach the lock-in condition.

Lock-in condition can only be reached after an undetermined number of demodulated data transitions (maximum 5) and during this time one or more bits can be lost. For this reason, if a sequence of bits that starts like: "1010-1010-1010-1010-…." (0xAAAA… in hexadecimal) is transmitted, the receiver can only demodulate with correct timings a part of this sequence.

For example, if the first "10101" is lost, the PC will receive the sequence "0101-0101-010….." (or 0x55 in hexadecimal). So, even if all bits are correct, byte synchronization is lost.

Figure 24 shows an example of timing diagram for a baud rate of 2400.

Figure 24. Demodulation timings for RX with preamble detection (@2400 baud)



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8.3 Communication session with Frame Synchronization

In this example, the board connected to COM1 is the Transmitter while the board connected to COM3 is the Receiver.

Five messages are transmitted across the Mains and the receiving method includes Frame Synchronization, so incoming data from ST7540 are supervised by the microcontroller on EVALCOMMBOARD and only the bits that follow the sequence "0x9B58" ("1001-1011-0101-1000") are sent to the PC.

Actions to perform on GUI connected with COM3:

1. Click **Rx** on toolbar to open the Rx Monitor dialog box.
2. Set **FRAME SYNC** to ON.
3. Write "9B58" in **Header** textbox and "FFFF" in **Mask** textbox.
4. Set **Data Bytes** to "36"
5. Click **ON**.

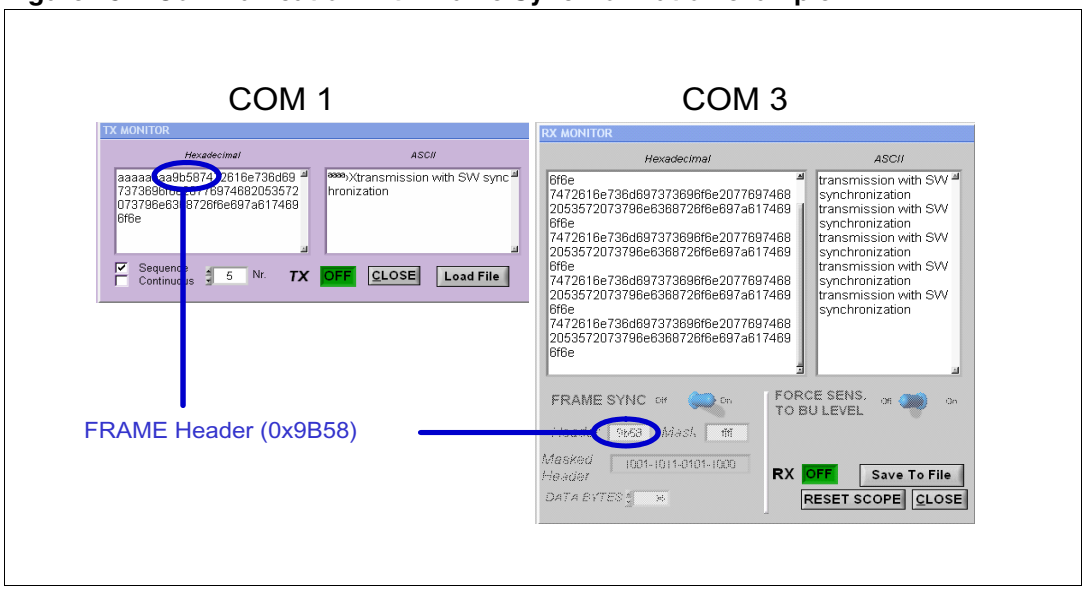
Actions to perform on GUI connected with COM1:

1. Click **Tx** on toolbar to open the Tx Monitor dialog box.
2. Write the preamble "AAAAAAAA" in the hexadecimal textbox.
3. Add the header "9B58" in the hexadecimal textbox.
4. Add the text string "transmission with SW synchronization" (length = 36 bytes) in the ASCII textbox.
5. Select **Sequence Mode** and set **Nr.** to “5”.
6. Click **ON**.

Five messages are transmitted.

Using the Frame Synchronization feature, the user ensures that the transmitted bytes always arrive synchronized to the PC as shown in *Figure 25*.

Figure 25. Communication with Frame Synchronization example



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8.4 Communication session with Hardware Frame Synchronization

In this example, the board connected to COM1 is used as the Transmitter while the board connected to COM3 is the Receiver. Five messages are transmitted across the Mains and the receiving method is synchronized by ST7540 through the Header Recognition function of the Control Register. This enables incoming data from the ST7540 to arrive already synchronized to EVALCOMMBOARD and are directly sent to the PC.

Actions to perform on GUI connected with COM3:

1. Click **REG** on toolbar to open the Control Register parameter dialog box.
   - Enable **Extended Register**.
   - Enable **Header Recognition**.
   - Enable **Frame Length Count**.
   - Set **Header Length Control** to "16 bits".
   - Set **Frame Header Control** to "9B58" (hexadecimal value).
   - Set **Frame Length Control** to "14" (hexadecimal value equal to twenty 16-bit words or 40 bytes).
   - Click **Write CTRL Register**.
2. Click **Rx** on toolbar to open the Rx Monitor dialog box.
   - Set **Frame Sync** to OFF.
   - Set **Force Sens. to BU Level** to OFF.
   - Click **ON**.

Actions to perform on GUI connected with COM1:

1. Click **Tx** on toolbar to open the Tx Monitor dialog box.
2. Write the preamble "AAAAAAAA" in the hexadecimal textbox.
3. Add the header "9B58" in the hexadecimal textbox.
4. Add the text string "transmission with ST7540 synchronization" (length = 40 bytes) in the ASCII textbox.
5. Select **Sequence Mode** and set **Nr.** to “5”.
6. Click **ON**.

Five messages are transmitted.

Using the Hardware Frame Synchronization feature, the user ensures that the transmitted bytes always arrive synchronized to the PC as shown in *Figure 26*.

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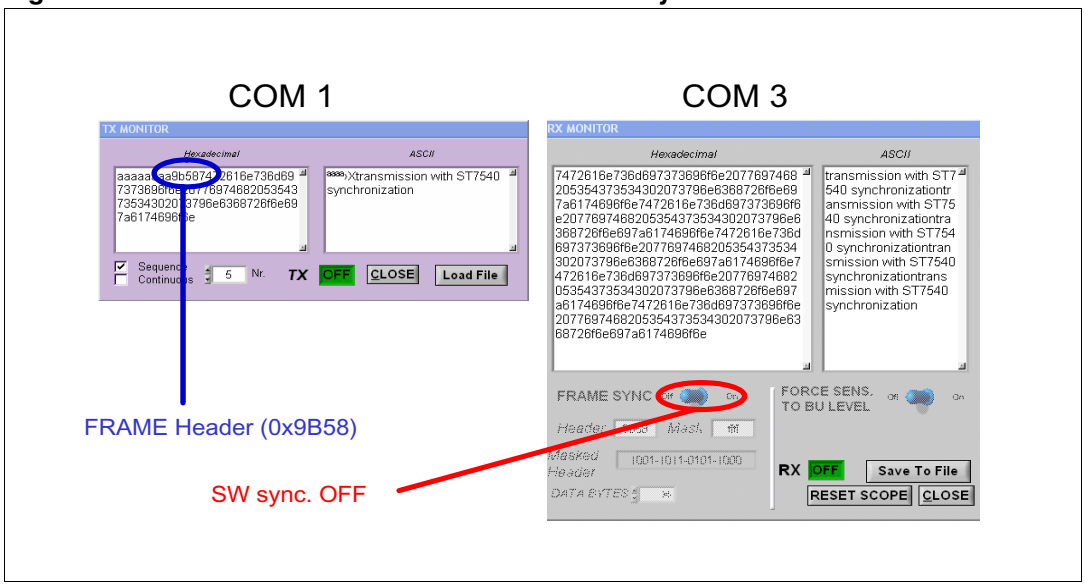
Figure 26. Communication with Hardware Frame Synchronization



8.5 Ping session

In this example, the board connected to COM1 is the Master while the board connected to COM3 is the Slave. 100 messages are exchanged from Master to Slave and statistical data (as for Master as for Slave) are saved in two text files.

Actions to perform on GUI connected with COM3:

1. Click **PING** on toolbar to open the Ping dialog box.
2. Select **Slave** and click **OK**.
3. Set **Slave Address** to "1".
4. Write "Ping session nr. 1" in **Slave Description** field.
5. Set **Medium Access Control** to "PD", **Max Wait Slot Nr.** to "10" and **Max Wait Time [ms]** to "1000".
6. Click **Ping Start**.

Actions to perform on GUI connected with COM1:

1. Click **PING** on toolbar to open the Ping dialog box.
2. Select **Master** and click **OK**.
3. Set **Master Address** and **Nr. of Slave Addresses** to "1".
4. Set **Nr. of Messages** to "100" and **Repetition Control** to "3".
5. Set **Wait Time [ms]** to "255".
6. Set **Medium Access Control** to "PD", **Max Wait Slot Nr.** to "10" and **Max Wait Time [ms]** to "1000"
7. Click **Ping Start** to start the ping session.

Saving statistics

When all messages are transmitted, on the Ping Master dialog box click **Save Statistics** and selecting the path and the name of the text file (in this case "Ping session nr. 1 (Master).txt").

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To save Slave statistics, click **Get Statistical Data** (to update the statistics), click **Save Statistics** and selecting the path and the name of the text file (in this case "Ping session nr. 1 (Slave).txt").

Figure 27. Ping master session and save statistics

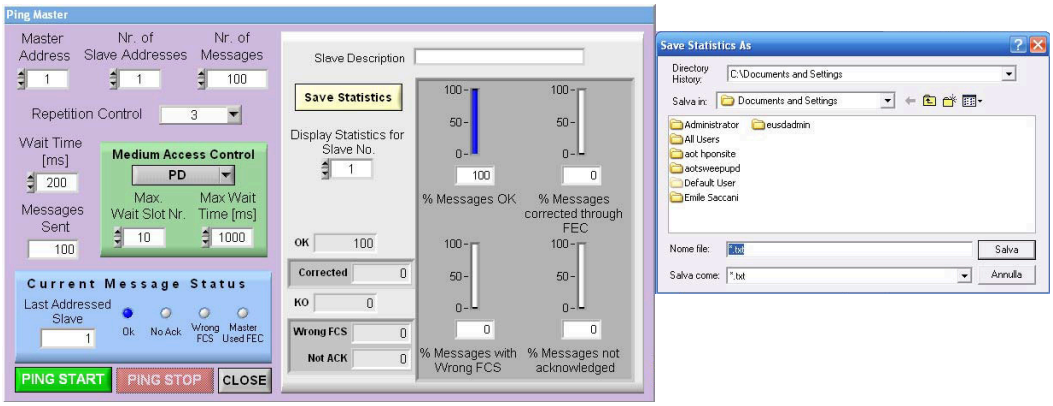
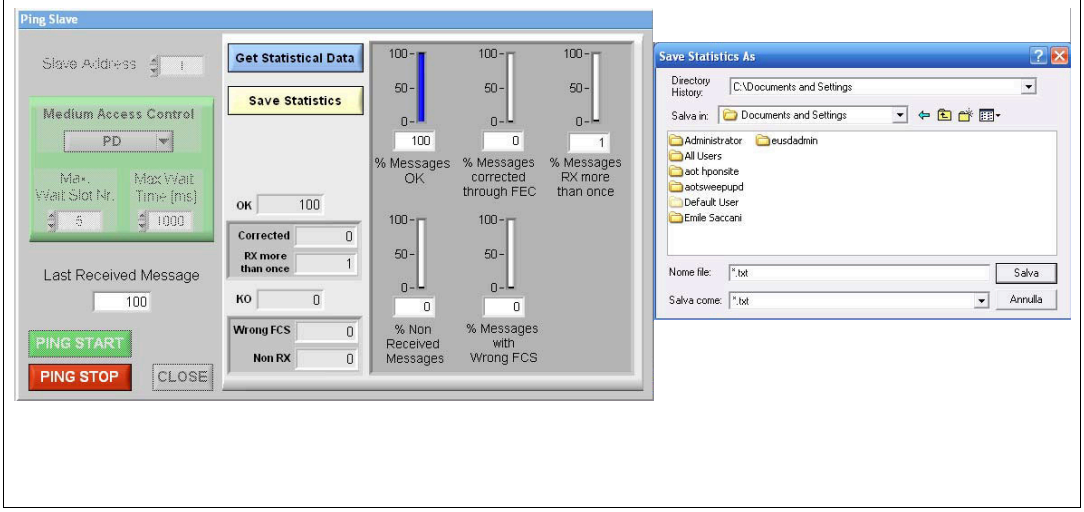


Figure 28. Ping slave session and save statistics



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9 Revision history

Table 26. Revision history

Date	Revision	Changes
24-Jul-2006	1	Initial release

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